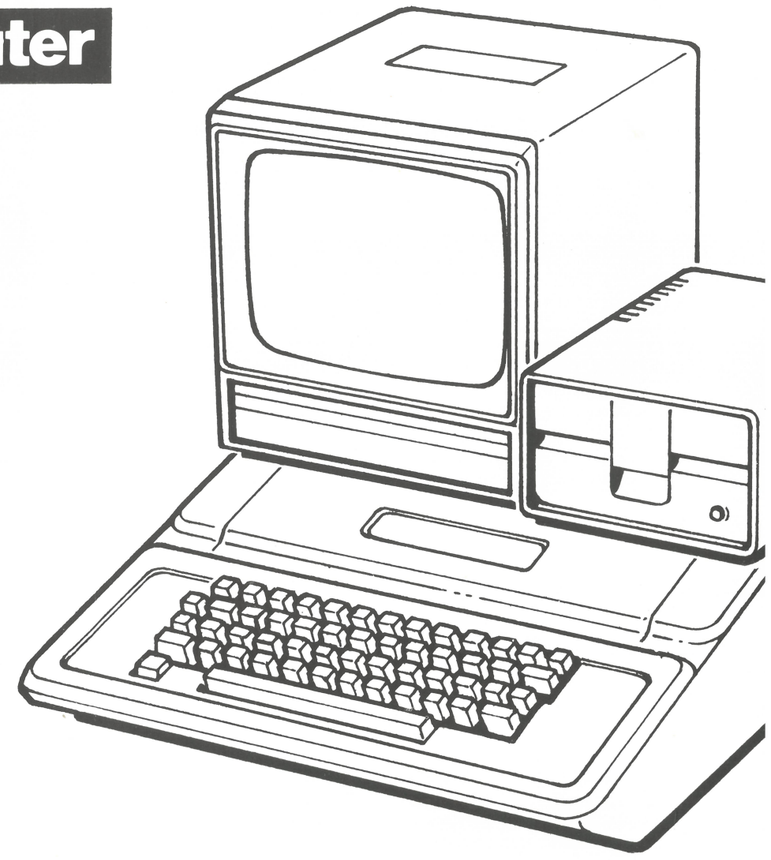
E.M.E

microcomputer program



SOUND AND VIBRATIONS

STUDY GUIDE

by

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OVERVIEW

The E.M.E SOUND AND VIBRATIONS program provides elementary students with an introduction to the nature of sound energy. The program consists of two parts:

1. Explanation -- includes two sections: (1) How sounds are produced, vibration, frequency and pitch; (2) How sound travels and reflected sounds. A convenient forward/backward feature allows review at any point.

2. Quiz -- consists of 15 randomly-selected questions to test student understanding of vibration, frequency, pitch, intensity and sources of sound. A short explanation is provided if a question is incorrectly answered. Quiz score is given at the end.

After students study the Explanation sections of the program, they will have a clear understanding of how sounds are produced and how they travel. This background will help them solve the problems found in the Quiz portion of the program.

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OBJECTIVES

The following concepts are developed in the program:

1. Sound is caused by vibrations.

2. Sounds travel in all directions from their point of origin.

3. The pitch of a sound is determined by the vibration rate (frequency) of whatever produces the sound.

4. Sounds travel through gases, liquids and solids but not through space or a vacuum.

5. Sound may be reflected; an echo is produced by reflected sound.

6. Humans can recognize sounds over a wide range of frequencies.

After using this program students will be able to:

1. Observe that sounds are created by objects that vibrate.

2. Recognize that vibration is a rhythmic back and forth movement of an object.

3. Show how vibrations affect the strength of sound.

4. Explain how the frequency of vibration relates to the pitch of sounds.

5. Test different materials for their ability to conduct sound.

6. Prove that sounds travel in all directions from their source.

USING THE PROGRAM

The E.M.E SOUND AND VIBRATIONS program is easy to use and is under your control at all times. The program loads automatically and is ready to use immediately. We suggest that students start with the Explanation sections. These provide students with the background needed to understand sound and to answer the quiz. The program is designed for Grades 4 and up.

You may wish to assign one student who has taken the quiz as your representative at the computer to record for you the scores of other students who take the quiz. The SOUND AND VIBRATIONS Quiz may also be used as an evaluation instrument by teachers who have completed a unit on this topic.

BACKGROUND

Sounds are so much a part of our lives that we often fail to notice them. Have students list the sounds they hear while sitting at their desks and describe them as soft or loud, high or low, pleasant or unpleasant, or using other descriptions of their choice. Point out the importance of sounds in bringing messages -- the blare of a car's horn, the crash of thunder, a bird's song and a church bell. Sound is one of the most important ways of communicating with others.

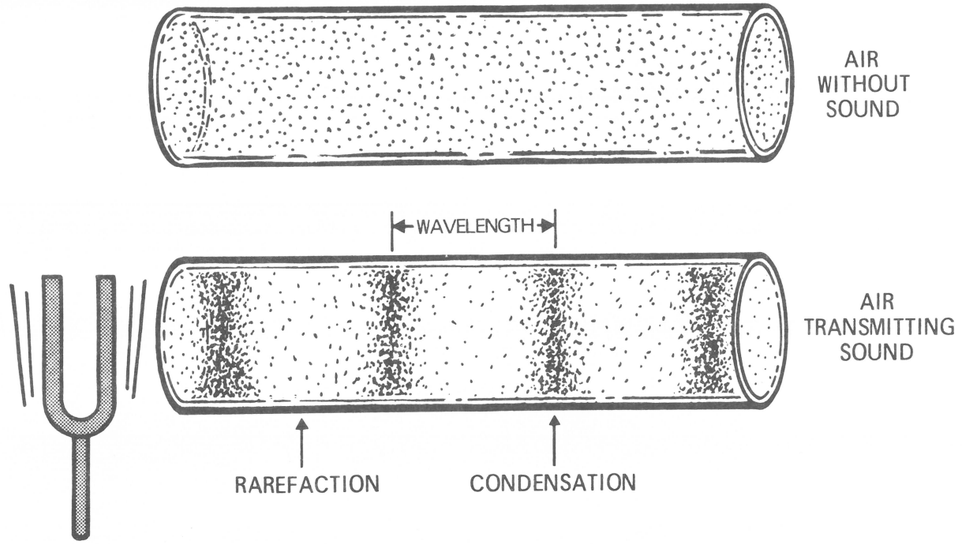
All sounds are produced by vibrations. These rhythmic back and forth movements cause waves that can move through solids, liquids and gases. Vibrations which can be detected by humans or animals are called sounds.

Stretch a rubber band between your fingers and pluck it. It will produce a sound.

Observe the back and forth motions of the rubber band. These are the vibrations which produce sound. When these vibrations stop, the sound stops.

Frequency is the measure of how many times an object is vibrating in a unit of time. The faster the object is vibrating, the higher the frequency. Frequency and pitch are directly related. As frequency increases, the sound that is produced has a higher pitch. Humans can hear frequencies ranging from about 20 to 20,000 vibrations per second. It is believed that some insects and other animals hear sounds humans cannot. There are whistles which produce high-pitched sound that dogs can hear but humans cannot. The SI (metric) unit Hertz (symbol Hz) is used to express frequency in vibrations (cycles) per second.

For a simplified description of sound waves, consider a tuning fork vibrating at one end of an open tube.



As the tip of the tuning fork moves outward, it pushes some air molecules to the right. They collide with other molecules to form an area, called a condensation, where molecules are tightly bunched. As the tip of the tuning fork moves to the left, air molecules flow into the space and form an area, called a rarefaction,

where the molecules are more widely separated. As the tuning fork continues its motion, sound vibrations -- a series of condensations and rarefactions -- travel away from it along the tube. This type of wave is called a compressional or longitudinal wave. In this type of wave the displacement of the particles of the medium is parallel to the direction in which the waves advance.

The distance between two adjacent areas of compression is called the wavelength. This is a measure of the pitch of the sound. Sounds with a low pitch have a long wavelength; those with a high pitch have a short wavelength. The maximum displacement of a molecule from its original position is the amplitude which is the primary factor affecting the loudness of the sound.

Sound waves move out in all directions from the source. If the source is a bell, it can be heard everywhere in a room -- near the floor and close to the ceiling. If a door is open, the sound may also travel out of the room and around corners.

In order for sound to travel the vibrations must have a carrier. The carrier may be any solid, liquid or a gas. Sound cannot travel across empty space. Because of this, there are no sounds on the moon or in outer space.

When we say that sound is traveling through the air (a gas), we mean that an energy wave called a "sound wave" is moving through the air. The particles of air set in motion by the vibrating source travel to your eardrum. The farther away you are from the source of the sound, the softer the sound becomes.

Sound waves also travel through water and other liquids. Have each student place an ear against the side of an aquarium filled with water while another strikes two stones under the water. The listener should be able to hear clearly the sound made by the stones. If possible, have your students do this experiment in a swimming pool.

Solids can also conduct sound waves. Have one student place an ear against one end

of a long table while another lightly taps the other end of the table with a pen or ruler. The student who is listening will hear the tapping clearly.

Does sound travel better through wood or air? Obtain a watch with a low but audible tick. Pick a student to listen to the ticking. Move the ticking watch away from the student's ear until the ticking cannot be heard. Next, touch one end of a meterstick to the student's ear and rest the stick against the watch. Can the student hear the ticking now? (The student should hear the ticking.) Move the watch to the end of the meterstick keeping the other end touching the student's ear. Will the ticking still be heard? (Yes.)

The speed of sound depends upon the medium through which it travels. In general, sound travels faster in solids and liquids than in air. At normal pressure and temperature, the speed of sound is about:

5,100 meters/second in steel
1,500 meters/second in water
340 meters/second in air

Compared with the speed of light, sound travels very slowly. Students may recall that there is often an interval of several seconds between the time they see a lightning flash and the time they hear the sound of the corresponding thunderclap.

Have you ever heard your voice come back to you as an echo from a building, cliff or hill? You hear your voice because sound bounces off certain surfaces, similar to the way a ball bounces off a wall. An echo is produced by a sound reflection. To hear an echo, you must be at least 16.75 meters away from the reflecting surface, otherwise the original sound and the reflected sound come so close together they cannot be distinguished.

There are times when it is necessary to concentrate sound waves to increase their audibility. One way to do this is to make a megaphone similar to those used by cheerleaders at sporting events. When a megaphone is used, the sound energy is concentrated rather than spread out over a wide space. You can make a megaphone

by rolling a piece of drawing paper into the shape of an open-ended cone.

Although the E.M.E SOUND AND VIBRATIONS program does not cover how humans hear, a brief description is useful. Our ears receive sound waves and convert them into nerve impulses. The ear consists basically of three parts: the outer ear, the middle ear and the inner ear. The outer ear collects vibrations. The middle ear changes the vibrations to nerve messages which are passed to the brain. Ask a student to research the topic "How We Hear" and report to the class.

ACTIVITIES

A tuning fork will be needed for these activities.

Strike a tuning fork on a solid object. This will cause the fork to vibrate. Hold it in the air over one end of a table. Place some children at the other end and ask if they can hear the tuning fork. Most will not be able to. Ask the children to figure out a way of hearing the tuning fork at a distance. One way is to set the stem of the vibrating tuning fork on the table and have them place an ear against the table. They should be able to hear the tuning fork as the sound travels through the table. Allow students to experiment with the vibrating tuning fork to find out what materials are good conductors of sound. Try sweaters, glass, rulers, neckties and long pieces of metal. Place the stem of a vibrating tuning fork on these materials and hold the other end of the object to another student's ear. (Sweaters and neckties are poor conductors; rulers, glass and metals are good conductors.)

Ask the music teacher to bring some musical instruments to your classroom and show the students how each one produces sounds. Try to display stringed, brass, keyboard, percussion and woodwind instruments. Also, have students make stringed instruments by stretching rubber bands of various widths across a small box. By plucking the bands, the students can discover much about sound. What happens when the rubber band is tightened? (The pitch goes up.) If a piano is available ask students to figure out how it produces sound and why some notes are high and others low. Create

a bulletin board of "Sounds We Like" and "Sounds We Do Not Like". The students may make drawings or cut our pictures from magazines which depict sounds they like or dislike.

Invite the school nurse or a doctor to your class to talk about how the ear functions and the proper procedures for good ear care. Make certain you have a large model or picture of the human ear for this activity.

A related topic that students may explore is the use of ultrasonics to chart the ocean floor, to detect flaws in metals, to clean teeth and for other medical, scientific and commercial uses.

STUDENT WORKSHEET ANSWERS

Worksheet I

1. T
2. T
3. F
4. F
5. T
6. T
7. F
8. T
9. F
10. T

Worksheet II

1. pitch
2. vibrate
3. directions
4. matter
5. echo
6. source
7. loudness
8. shorter
9. spread out
10. empty space

This program uses a high-speed operating system called
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GLOSSARY

amplitude: In a wave, how far a particle moves from rest to its maximum displacement.

compression: A region of high pressure in a wave such as a sound wave.

frequency: The rate at which an object is vibrating: the higher the rate, the higher the frequency.

pitch: How high or low a sound is: the higher the sound, the higher the pitch.

rarefaction: A region of minimum pressure in a wave such as a sound wave.

source: Matter which vibrates and produces sound.

ultrasonic: Having a frequency greater than the maximum audible to the human ear, 20,000 vibrations per second.

vibration: A rhythmic back-and-forth movement in an object.

wave: A vibration that travels along the surface of a liquid or through a solid, liquid or gas.

RESOURCES

Books

Branley, Franklyn M.: HIGH SOUNDS, LOW SOUNDS, Thomas Y. Crowell, New York, 1975.

Heuer, Kenneth: THUNDER, SINGING SANDS, AND OTHER WONDERS: SOUNDS IN THE ATMOSPHERE, Dodd, Mead, New York, 1981.

Kavaler, Lucy: THE DANGERS OF NOISE, Thomas Y. Crowell, New York, 1978.

Knight, David C.: SILENT SOUND: THE WORLD OF ULTRASONICS, Morrow, New York, 1980.

Thomas, Anthony: THINGS WE HEAR, Franklin Watts, New York, 1976.

Films

SOUNDS ALL ABOUT US, Coronet, Chicago, IL (11 minutes)

SOUNDS AROUND US, Cenco Education Films, Chicago, IL (10 minutes)

SOUNDS -- HOW THEY TRAVEL, Academy Films, Hollywood, CA (11 minutes)

SOUND WAVES, Encyclopedia Britannica, Chicago, IL (16 minutes)

SOUND WAVES AND THEIR SOURCES, Encyclopedia Britannica, Chicago, IL (16 minutes)

Name_____ Student Worksheet I

SOUND AND VIBRATIONS

True or False. Circle the T if you think the answer is true. Circle the F if you think the answer is false.

1. T F Sounds are caused by objects that vibrate or move back and forth quickly.
2. T F The pitch of a sound depends on how rapidly the source vibrates.
3. T F The frequency of a vibrating object does not depend on its length.
4. T F Sound cannot travel around corners.
5. T F Sound energy is picked up by a person's ears.
6. T F The loudness of sound depends on how close you are to its source.
7. T F Humans can hear sounds that dogs cannot.
8. T F Sound can travel through water, air, metal, plastic and wood.
9. T F A person swimming under water can hear no sounds.
10. T F An echo is a sound reflected back to its source.

Name_____ Student Worksheet II

SOUND AND VIBRATIONS

Use the words listed below to fill in the blanks in the sentences.

brain	shorter	vibrate	loudness	directions
pitch	echo	matter	source	empty space
spread out				

1. A gym teacher's whistle has a higher_____than an auto horn.
2. Sounds are caused by things that_____quickly.
3. Most sounds move out in all_____from the source.
4. Sounds can travel through all_____.
5. Without a surface to reflect sound, there is no_____.
6. and 7. As a sound wave travels out from its_____there is a decrease in_____.
8. Making the vibrating part of a ruler_____causes its frequency to be greater.
9. A long, open tube carries sound well because sound cannot_____ in it.
10. Sound cannot travel through_____.

TEXTBOOK CORRELATION GUIDE

Addison Wesley	
Science	Book 4, Chapter 8
Coronado	
Science & Technology	Book 4, Unit 5, Chapter 15
Harcourt Brace	
Science	Book 2, Unit 6 Book 4, Unit 2, Chapters 1-5
Heath	
Science	Book 2, Unit 2, Chapter 2
Holt	
Elementary Science	Book 5, Unit 2, Chapters 4,5
Laidlaw	
Exploring Science	Book 3, Unit 4, Chapters 1,2 Book 6, Unit 4, Chapter 1
Merrill	
Accent on Science	Book 2, Chapter 2 Book 4, Unit 6, Chapters 1-3
Scott Foresman	
Science	Book 3, Chapter 4 Book 5, Chapter 14
Silver Burdett	
Science	Book 3, Unit 2, Chapter 8